

**NATIONAL
INSTITUTE
OF**

**OCEANOGRAPHY
INDIA**

1966-67



317

**COUNCIL OF SCIENTIFIC AND
INDUSTRIAL RESEARCH**

ANNUAL REPORT

2

1966 - 67



NATIONAL INSTITUTE OF OCEANOGRAPHY

(Council of Scientific & Industrial Research)

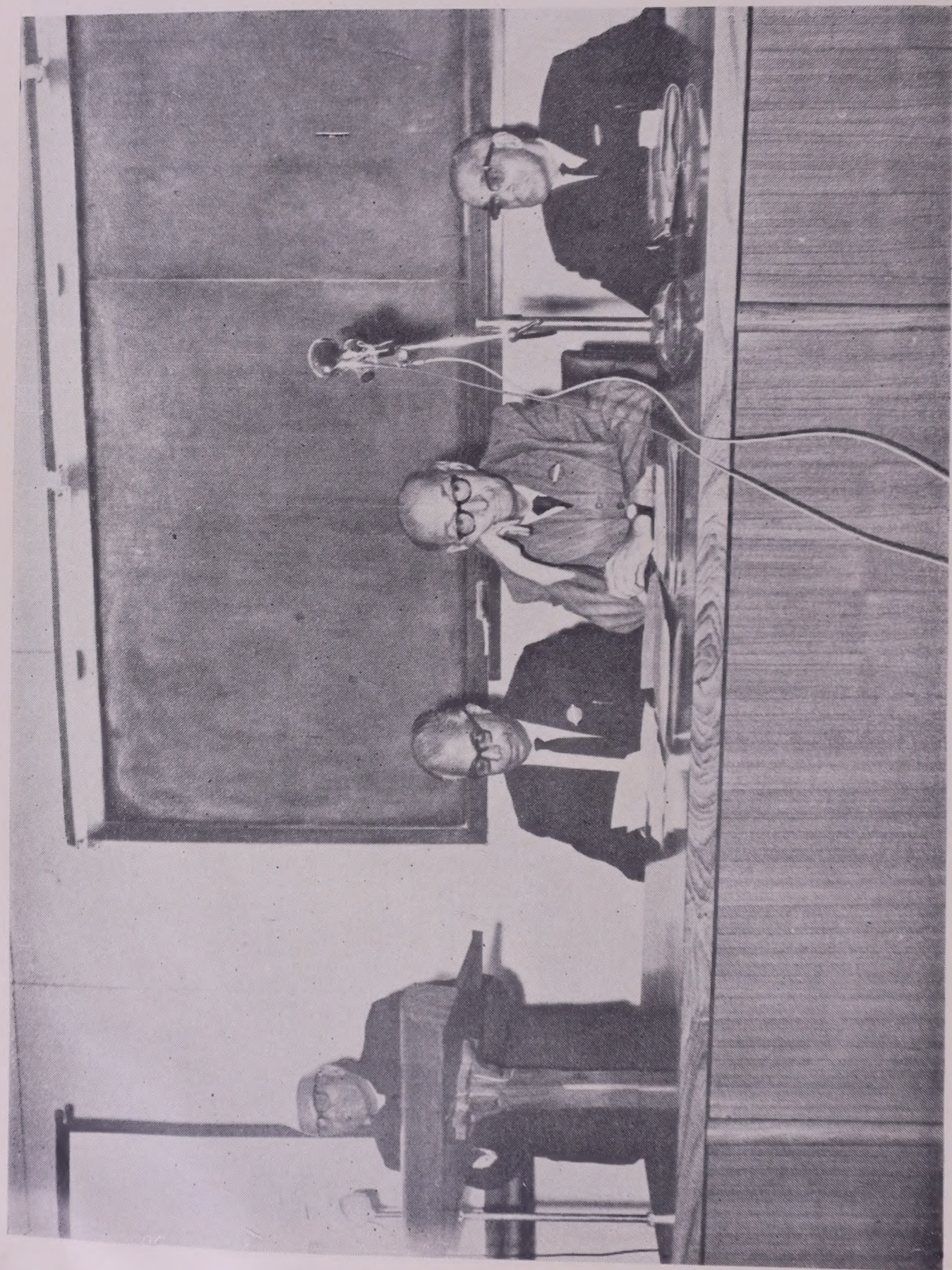
NEW DELHI



**Dr. D. N. Wadia, F.R.S., Chairman, Indian National Committee on Oceanic Research
inaugurating the Symposium on Indian Ocean.**

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Dr. Atma Ram, D.G.S.I.R. and Vice-President, National Institute of Sciences of India, delivering his address at the Symposium on Indian Ocean — sitting (from left to right) Dr. N.K. Panikkar, Dr. D.N. Wadia, Prof. T.R. Seshadri.

INTRODUCTION

This report gives an account of the activities of the National Institute of Oceanography, from 1st April 1966 to 31st March 1967.

As stated in the last year's report the Institute has taken over all the activities and units of the former Directorate of Indian Ocean Expedition. It is now functioning in four Divisions and two units. These are: Planning and Data Division (Indian National Oceanographic Data Centre) at New Delhi; Physical and Biological Oceanography Divisions and Indian Ocean Biological Centre at Ernakulam; a unit for Liaison work and Gulf of Cambay studies at Bombay; and a field unit in Goa—the last mentioned functioning only from May 1967. This report highlights the work of the Data Centre, gives an account of data holdings and exchanges made so far, progress made in the physical, coastal and nearshore studies at the Physical Oceanography Division, Productivity and Ecological studies on Marine and Estuarine communities at the Biological Oceanography Division, the status of plankton sorting and the research on the special groups at the Indian Ocean Biological Centre, and the starting of the Surveys of Gulf of Cambay and Gulf of Kutch with special reference to biological and geological features.

N. K. PANIKKAR
Director



Participants at the NISI/INCOR Symposium on "Indian Ocean" (from left to right) — Prof. V. N. Greze, Dr. N.K. Panikkar, Prof. J. Krey, Prof. T.S. Rass, Dr. Walter Fischer, Prof. W. Schott, Prof. T.R. Seshadri.

2. NATIONAL INSTITUTE OF OCEANOGRAPHY & ITS DIVISIONS

The National Institute of Oceanography is functioning with four full divisions and two units. They are given below:

Division & Units of the Institute

	<i>Name and Address of the Division</i>	<i>Telephone Number</i>	<i>Telegraphic Address</i>
1.	Planning and Data Division, B-7, Hauz Khas, New Delhi-16	73353	Oceanology New Delhi
2.	(a) Indian Ocean Biological Centre, Ravipuram Sannidhi Road, Ernakulam-6	3384	Oceanology Ernakulam
	(b) Indian Ocean Biological Centre, University Oceanographic Laboratory, Foreshore Road, Ernakulam-6	3306	-do-
3.	Physical Oceanography Division, Karikkamuri Road, Ernakulam-1	3538	Geophysics Ernakulam
4.	Biological Oceanography Division, Karikkamuri Cross Road, Ernakulam-1	814	-do-
5.	Bombay Unit of the National Institute of Oceanography, Hornbill House, Opp. Lion Gate, Apollo Street, Bombay-1	257277	Hornbill Bombay

2.1 PLANNING AND DATA DIVISION—INDIAN NATIONAL OCEANOGRAPHIC DATA CENTRE, NEW DELHI

During the year under review the Data Division has continued to receive the IIOE data from different sources. The physical data, collected by INS *Kistna* during her cruises of 1963 and 1964 and which had been preliminarily processed at the Directorate of Scientific Research (Navy) in accordance with the earlier recommendation of the Indian National Committee on Oceanic Research, were received during the year. These data are for the cruises 14, 15-17, 19 & 20 and stations 315, 333-443 & 511-540.

In addition to INS *Kistna* data, the Centre also received from the World Data Centre 'A', Oceanography, Washington, the physical and chemical data collected by

ships like R.V. *Argo* (USA), U.S.C. & G.S.S. *Pioneer*, R.R.S. *Discovery* (U.K.), Commandant Robert *Giraud* (France), R.V. *Jalanidhi* (Indonesia) and R.V. *Vityaz* (U.S.S.R.). Details pertaining to the data from these various ships as well as from INS *Kistna* are given in the accompanying table.

All these data have at present been classified and stored. The work of quality checking of the INS *Kistna* data is being continued. The procedure of quality-checking as adopted is a manual one involving the plotting of data on special data forms like SIO-MLR Forms, working of T.-S. correlations and checking up inversions, smoothing distribution etc. The faulty data as revealed by inversions in the density distribution, particularly in the deeper layers are either rejected or re-examined with reference to the original unprocessed station data from the log sheets. The work involved is considerable and during the year, the work was carried out by a single research fellow. Since both, quality checking and tabulation of checked data have to be done by a single individual, transfer of data to standard data cards is taking a considerable amount of time.

Apart from receiving, checking, processing, storing and exchanging the physical and chemical data, the activities of the Data Centre are being extended towards the analysis of the data in certain selected sections with a view to studying the vertical and horizontal distributions of the various oceanographic parameters; some of these analyses in respect of temperature, salinity, density (σ_t), oxygen and phosphate data for the cruises of INS *Kistna*, O-III and IV-VII have been completed for the upper 500 meters. Based on these analyses, two papers dealing with the conditions in the central and southern Bay of Bengal and the northern Equatorial Indian Ocean, were presented at the Indian Ocean Symposium in March 1967.

In addition to the physical and chemical data, data relating to the fisheries resources of the Indian Ocean with particular reference to distribution of a few of the important fisheries including the Tunas and Tuna-like fishes were compiled. Work also was taken up as an experimental measure on the preparation of a map showing the important physiographic features of the northern Indian Ocean on the basis of available data.

Requests for oceanographic data have been comparatively few during the current year. A few technical enquiries such as areas of occurrence of diatomaceous oozes, seaweed exploration possibilities have been attended to.

DATA RECEIVED AT THE DATA DIVISION, NEW DELHI

Name of the R/V	Year	Cruise No.	Station No.	Remarks
1	2	3	4	5
INS <i>Kistna</i> (INDIA)	1963	XIV	315—352	Processed data sent by DSR (Navy)-T, S, O ₂ , Sigma-t.
	1964	XV—XVII	353—443	
		XIX, XX	511—540	

<i>Argo</i> (U.S.A.)	1960	Monsoon Expd.	Oceanographic station data sent by NODC, Washington. 37 Stns. T,S, Sigma-t, Sound Velocity, O ₂ .	
	1962	Lusiad II Expd.	104 Stns. T,S, Sigma-t, Sound Velocity, O ₂ , Phosphate, Nitrate, Silicate.	
		Lusiad III Expd.	30 Stns. T,S, Sigma-t, Sound Velocity, O ₂ .	
	1963	Lusiad V Expd.	105 Stns. T,S, Sigma-t, Sound Velocity, O ₂ , Phosphate, Nitrite.	
		Lusiad VI Expd.	16 Stns. T,S, Sigma-t, Sound Velocity, O ₂ .	
<i>Pioneer</i> (U.S.A.)	1964	442	63 stns.	- T,S, Sigma-t, Sound Velocity, Silicate for few depths only.
<i>Discovery</i> (U.K.)	1963	1	73 stns.	- T,S, Sigma-t, Sound Velocity, O ₂ , Phosphate, Nitrate, Silicate.
	1964	3	312 Stns.	- T,S, Sigma-t, Sound Velocity, O ₂ , Phosphate, Nitrate, Silicate.
<i>Commandant Robert Giraud</i> (FRANCE)	1962	4	115 Stns.	- T,S, Sigma-t, Sound Velocity.
<i>Jalanidhi</i> (INDONESIA)	1963	1-4	43 Stns.	- T,S, Sigma-t, Sound Velocity, O ₂ , D and Phosphate for a few Stns. only.
<i>Vityaz</i> (U.S.S.R.)	1959—60	31	216 Stns.	- T,S, Sigma-t, Sound Velo-
	1960—61	33	201 Stns.	city, O ₂ , Phosphate, Nitrate,
	1962	35	120 Stns.	Silicate, pH.

2.2 INDIAN OCEAN BIOLOGICAL CENTRE, ERNAKULAM

The Indian Ocean Biological Centre has been actively functioning for over four years since November 1962. The main function of the centre is handling standard sam-

ples of zooplankton collected by the research ships of all the countries which participated in the International Indian Ocean Expedition, and since 1st January 1966, it is continuing as a division of National Institute of Oceanography. During the past years the Indian Ocean Biological Centre has made steady progress in sorting of zooplankton collections and in the development of plankton research activities. It has proved its usefulness, and in recognition of which a 5-year contract has been entered into by the CSIR with the UNESCO.

(a) **Plankton sorting**

This has proceeded at a steady pace during 1966-67. Besides the regular sorting of the samples, re-sorting of the earliest sorted samples has also been done very carefully and the work is in progress. The sorting work done during the year is briefly indicated below:

Number of sorted samples on 31-3-1966	1322
Number of samples sorted during 1966-67	249
Total sorted samples on 31-3-1967	1571
Number of unsorted samples on 31-3-67	610
Total number of IIOE plankton samples at IOBC	2181
Total number of samples requiring re-sorting	190
Re-sorted samples till 31-3-67	87
Samples to be re-sorted	103

(b) **Plankton research**

Dr. Edward Brinton, Curator is making a study of the bio-geographical distribution of the Euphausiacea; he is assisted by Shri K. Gopalakrishnan. Shri M. Krishna Menon, Scientist, continued his study of decapod larvae and has initiated a programme of sub-sorting the collection from each station in about two dozen groups. So far, collections from 551 stations have been sub-sorted. Shri L.R. Kasturirangan is engaged on the studies of the group Copepoda and the mapping of the distribution of this group. Dr. R.V. Unnithan, Scientist, continued his work on the 'Micro-associates of marine fishes'. The more experienced from among the sorting assistants have progressed towards specialized work. These include sub-sorting a selected group, consultation of scientific and taxonomic literature relevant to this group and planning the course of future research on this group.

The names of persons carrying out detailed studies on the various groups are indicated below along with the groups of their specialization.

Shri P. Gopala Menon	Decapod Larvae
Shri M. Sakthivel	Mollusca, Pteropoda, Thecosomata.
Shri K.J. Peter	Fish eggs and larvae
Shri P.N. Aravindakshan	Mollusca, Heteropoda

Shri George Peter
Shri Jacob George
Smt. Vijayalakshmi R. Nair
Shri T. Balachandran
Shri K. Gopalakrishnan

Pelagic Polychaeta
Ostracoda
Chaetognatha
Pelagic Anthozoa
Euphausiacea

Based on detailed studies, a number of distributional charts have been prepared showing the distribution of various groups of planktonic animals in the Indian Ocean. Some of these charts were exhibited at the time of the Symposium on Indian Ocean held at the National Institute of Sciences of India, New Delhi in the first week of March 1967.

A number of scientists both from India and abroad who are well-known specialists in certain groups visited the Centre and spent some time examining the sorted fractions and provided scientific guidance and advice to the various workers at the Centre. Among these mention is made of the following :

Dr. Kenneth McKenzie of Monash University, Clayton, Victoria, Australia, spent two weeks at IOBC (7th to 20th October, 1966).

Dr. (Madam) N.N. Gorbunova of the Institute of Oceanology, Moscow (USSR) was at IOBC for 3 weeks (20th October to 14th November, 1966) and examined the sorted fractions for fish larvae. She also assisted the IOBC staff in the identification and detailed study of larval fishes. She also trained one or two workers in the method of identifying fish larvae, especially those of the Scombroid group.

Dr. R. Fenaux of France spent some time examining the Appendicularia in the collections.

Dr. N.K. Panikkar, during his visits to the Centre gave assistance in the sub-sorting of pelagic anthozoa in which one member of the staff is specializing.

In addition to the scientists who spent time at the Centre examining the International collections, a number of distinguished marine biologists from India and abroad visited the Centre and held discussions with the scientific staff at the Centre.

Distribution of Sorted Material to Specialists

Copelata	Approximately half of the collection has been sent to Dr. Fenaux, who has, in turn arranged for Dr. Buchman to receive some of the Arabian Sea material.
Cumacea	Given to Dr. C.V. Kurian
Mysidacea	To Dr. Krishna Pillai and Mrs. Olive Tattersall, who have agreed to collaborate. The former is receiving the material.
Phyllosoma	To Dr. R. Prasad & Shri P.R.S. Tampi.
Euphausiacea	To Dr. Edward Brinton and Mr. K. Gopalakrishnan.

Thecosomatous
pteropods
Ostracoda

To Shri M. Sakthivel with guidance from Dr. McGowan.
To Shri Jacob George with guidance from Drs. McKenzie
and Illes.

Distribution pending

Stomatopoda to Alikunhi.
Foraminifera to Allan Be'
Amphipoda to Gruner, Vinogradov, Bowman*
Polychaetes to Teddle-George Peter*
Chaetognaths to T.S.S. Rao, Alverino, Mrs. Nair
Sergestidae to Tirmizi
Siphonophores
Meroplankton
Fish eggs and larvae
Decapoda (Penaeids to IOBC)
Cephalopoda to Okutani

Handbook on IOBC Collections

This is presently in the form of mimeographed list of the collections with key appended. This list would be published after maps of cruise tracks and summary of the oceanographic environment are finished. Efforts are being made to expedite publications of a handbook on the collections at the Indian Ocean Biological Centre.

Zooplankton atlases

Preliminary charts of the 'General Properties' i.e. total copepoda, fish larvae, chaetognaths, etc. have been prepared based on average densities for 5 marsden squares; the data for these charts are from the 1285 standard samples sorted so far.

When all samples from particular regions are processed, the preparation of Atlases of those regions are taken up. For instance, the processing of data for the Arabian Sea down to the equator has been completed and these data have been incorporated in the first series of Atlases for the Arabian Sea. The data for Bay of Bengal would be ready within two or three months and the preparation of Atlas for this region will be taken up.

The projection provisionally adopted for use is the same sinusoidal equal-area projection adopted for the plotting of the IIOE physical and chemical data by Klaus Wyrski.

Fifth Meeting of the Consultative Committee for IOBC

The Fifth Meeting of the Consultative Committee for IOBC was held from February 28 to March 8, 1967. The meeting was held in two parts: in Delhi from

*To be finalised

February 28 to March 4 and in Ernakulam from 6 to 8. The following is the list of the participants :

1.	Prof. J. Krey	Chairman
2.	Dr. A. Fleminger	Member
3.	Dr. M. Anraku	Member
4.	Dr. V.N. Greze	Member
5.	Prof. S. Krishnaswamy	Member
6.	Mr. D.J. Tranter	Member
7.	Dr. N.K. Panikkar	Member-Secretary
8.	Prof. P.N. Ganapati	Indian Advisory Board to IOBC
9.	Dr. A.P. Kapoor	-do-
10.	Dr. Raghu Prasad	-do-
11.	Dr. Edward Brinton	Curator, IOBC
12.	Dr. S. Z. Qasim	NIO, Ernakulam
13.	Dr. A.C. Evstafiev	Director, Unesco Regional Office, New Delhi
14.	Shri L.R. Kasturirangan	Asstt. Curator, IOBC
15.	Shri R. Jayaraman	NIO, New Delhi
16.	Dr. S.N. Dwivedi	NIO, New Delhi

Dr. N.K. Panikkar, Director, IOBC presented a brief report on the working of the IOBC wherein he discussed the useful part IOBC has played in regard to studies on Indian Ocean plankton and emphasized the need for its further expansion. He pointed out the steady progress made at the Centre in the sorting of zooplankton collections and development of plankton research activities, acquisition of a site of 1.1 acre of land at Ernakulam for the construction of permanent IOBC Building, and expansion of laboratory and library facilities. He also informed the members about the salient points in the contract between the UNESCO and the CSIR for the development of the Centre.

Dr. E. Brinton, Unesco Curator for the IOBC gave his report for the period from January 1966 to February 1967. The report mainly dealt with the international collections received during the period, the progress and status of the sorted and unsorted samples, sub-sorting, specialised studies by the staff, distribution of sorted material to the specialists, compilation of a hand-book of IOBC collection and the preparation of an Atlas relating to the distribution of zooplankton.

The joint meeting of the Indian Advisory Board and the UNESCO Consultative Committee for IOBC was held in the forenoon of the 1st March 1967 in the CSIR Conference Room under the chairmanship of Dr. D.N. Wadia, Chairman of the Indian National Committee on Oceanic Research. Dr Wadia, Dr. Atma Ram, DGSIR and Prof. J. Krey, Institut fur Meereskunde der Universitat Kiel and Chairman of the Consultative Committee for IOBC spoke appreciatively about the progress of the work in the IOBC. Dr. Atma Ram, DGSIR made particular reference to the manner in which several countries cooperated with the Centre by sending the collections to the Centre and stated

that the Council has given high place for the development of oceanographic researches in the country.

Recommendations of the Consultative Committee

Regarding the routine sorting and sub-sorting of the International collections, the following recommendations were formulated and adopted.

A. Equipment for sorting and research

The Consultative Committee recommended that the Curator should, within the terms of the UNESCO-CSIR contract, request for microscopes, camera lucidae and other necessary equipment from UNESCO to meet the present and future needs of IOBC and that priority of requirements should be indicated.

B. Fellowships at the IOBC

Regarding the fellowships the Committee recommended:

1. That CSIR allocate 4 to 6 fellowships to IOBC to expedite the programmes of basic sorting, sub-sorting and research, and that these fellowships be made available to candidates from the Indian Ocean region.
2. That Unesco provide fellowships to students from countries of Indian Ocean region who wish to be trained at the IOBC in the systematics of tropical zooplankton.
3. That Unesco allocate 2 to 3 fellowships each year to scientists at the IOBC for specialised training at other laboratories and that Unesco also encourage bilateral arrangement between India and other countries for this purpose.

C. Regarding special analysis of the International Collections the Consultative Committee recommended:

1. That the Curator should complete the Handbook as early as possible for publication by CSIR.
2. That a second volume of the Handbook be prepared listing the environmental data relating to the International Collections.
3. That the Curator should invite specialists to correspond with senior sorters at the IOBC to ensure scientific collaboration in the field of zooplankton.
4. As there are several specialists who have expressed their interest in a particular group, the Committee recommended that one of them should be recognised by the Curator as "Senior specialist" for that group and should be vested with the authority to correspond and collaborate with the others in order to ensure that the material in that group will be handled to the best advantage.

D. In regard to specialised studies the Committee recommended as follows :

1. The Committee requested Dr. Fleminger to draw up a plan of action for the copepods, keeping in view all the specialists in the field of Copepoda, and to submit this to the members of the Consultative Committee for approval.
2. Regarding Ahlstrom report, the Committee recommended that the author be asked to edit it with a view to its publication by Unesco in the IIOE Newsletter giving more emphasis on the factual aspects.
3. That Dr. Ahlstrom be asked to compile a list of that literature essential for fish larvae identification; that K.J. Peter, the senior specialist sorter, be asked to determine which of these references are available at the IOBC; and that Unesco be asked to obtain those that are not available at the Centre through Dr. Ahlstrom.
4. That arrangements be made for K.J. Peter to visit the Laboratory of Prof. Rass (Moscow) to examine the fish larvae collections after completion of his training at Copenhagen.
5. That Prof. Rass be asked to prepare a plan of action for coordinating the study of the fish eggs and larvae in the collections, and that he be asked to visit IOBC as soon as possible in connection with this work.
6. For Euphausiacea, the Consultative Committee agreed that the selection of specialists may be made based on the recommendation of the Curator and by a majority decision of Consultative Committee.

E. As regards the preparation of IIOE Atlas and the problems thereof, the Consultative Committee recommended :

1. That the "General properties Atlas" being produced under the direction of Dr. Panikkar and Dr. Brinton should also acknowledge the individual work of other collaborators.
2. That the 'Atlas of the species' should appear in loose leaf form for later re-assembly, since the data relating to species will become available at varying intervals over a period of years.

Some of the other important recommendations of the Committee are:

1. That the Curator may investigate the merits of replacing the formalin with alcohol or other preservatives to keep up better state of preservation of some of the delicate samples at the IOBC.
2. That a member of IOBC staff be encouraged to develop experimental interest in the problems of plankton preservation.
3. That an air-conditioned room be provided at the Centre to house the sub-sorted material and reference collections and a "Collection Tender" be appointed whose sole responsibility would be to ensure that the collections are kept in good condition.

4. That UNESCO distribute a pamphlet prepared by the Curator in consultation with the Director of IOBC (NIO) indicating the facilities and opportunities available at the IOBC for visiting research workers.
5. That the Curator should lodge all data arising from the International collections with World Data Centres, through the Indian National Oceanographic Data Centre, as soon as the scientists entrusted with each phase of the work have made their data available.
6. That regular weekly or fortnightly discussions or seminars be held to promote scientific interest among the staff.
7. That senior sorters be allowed to specialise in biological studies on individual species as well as on taxonomic work, with the supervision and approval of the Director of IOBC.
8. That UNESCO take steps to assure that the position of Curator of the International Collection is not left vacant after Dr. Brinton's departure.
9. That the next meeting of the Consultative Committee 1968 be held entirely at Ernakulam, commencing on February 22, the members assembling at Bombay on February 21.

2.3 PHYSICAL OCEANOGRAPHY DIVISION, ERNAKULAM

The main research activities undertaken at the Physical Oceanography Division during the year are :

- A. Processing and analysis of physical oceanographic data collected under the Indian Programme of International Indian Ocean Expedition.
- B. Physical and Chemical studies on the shelf sediments off the coasts of India.
- C. Coastal and nearshore Oceanographic studies along the Kerala coast.
- D. Bathymetry and submarine canyons.
- E. Estuarine Studies.

A. Analysis of cruise data

Data relating to cruises 15, 16, 17, 25 and 26 of INS *Kistna* was analysed for the following aspects :

- (i) Space variation of physical parameters like temperature, salinity, density etc.
- (ii) Study of circulation pattern including the dynamic computation,
- (iii) Characterisation, depth of location and spreading of water masses,
- (iv) Upwelling along the Indian coasts,
- (v) Long and short period internal waves and
- (vi) Thermocline and its space variation.

The results obtained are briefly summarised below :

Dynamic computations and geostrophic flow : Dynamic computations show that in the Bay of Bengal, the level of least motion exists at a depth of around 500 meters during the monsoon period. The circulation in the western Bay of Bengal during the south-west monsoon period (June, 1964) is characterised by the presence of two anticyclonic cells centred at $11^{\circ}\text{N } 83^{\circ}\text{E}$, and $16^{\circ}\text{N } 85^{\circ}\text{E}$ with a zone of strong cyclonic shear between them. The speed of the surface current exceeds 3 knots in certain areas in the Bay of Bengal. The strength of circulation decreases with the depth and becomes feeble at a depth of about 400 metres.

Water masses : From the hydrographic data and T.S. plots various water masses have been identified in the upper 500 meters in the Bay of Bengal and Arabian Sea. During the south-west monsoon period the Persian Gulf and the Red Sea waters enter the Bay of Bengal at its southern end at depths of around 200 and 400 meters respectively and follow the circulation pattern at their respective depths of entry atleast upto 15°N . These waters enter the western Bay of Bengal and spread during the south-west monsoon period under the influence of the clock-wise circulation in the Bay of Bengal and gradually lose their identity after the south-west monsoon period.

Upwelling : A comparison of the physical characteristics of the shelf waters in the central and southern parts of the east coast of India during the pre-monsoon and monsoon periods revealed the presence of upwelling but with the following differences :

- (i) Upwelling is weak in the southern part of the east coast; waters from shallow depths reach the surface nearshore and there is no marked lowering surface temperature near the coast.
- (ii) Upwelling is prominent in the central part of the east coast both during the pre-monsoon and monsoon periods. Waters from the deeper layers of the shelf (about 100 metres) reach the surface causing considerable fall of temperature near the coast during the later period.

Internal Waves : Oceanographic surveys in the open ocean region of the Bay of Bengal in the monsoon period showed vertical cross sections with striking wave like disturbances of the isotherms, isohalines and isopycnals in the thermocline region. The wavelengths vary from 150 kilometers to about 500 kilometers. But the waves of any particular latitude have the same wavelength approximately. These waves appear to be standing oscillations whose characteristics are governed by the dimensions of the Bay. Internal waves of short period are also observed during some of these cruises, generally in association with slicks in some of the areas in the Bay of Bengal and Arabian Sea. These internal waves are found to be of progressive type.

Thermocline: Studies on the space variations of thermocline depths and temperature gradients in the Upper 100 metres of the thermocline in the western Bay of Bengal in the south-west monsoon period show that the depth of the thermocline varies from

30 to 120 metres and the temperature gradient vary from 6°C to 14°C per 100 metres. Shallow thermocline areas are associated with weak temperature gradients and the deep ones with strong gradients in general in the southern half of the western part of the Bay of Bengal, while in the northern region no such clear cut relationship exists between the thermocline depths and the temperature gradients in the upper 100 metres of the thermocline region.

B. Studies on the shelf sediments

The shelf sediments collected during the 17th, 18th and 26th cruises of INS *Kistna* covering the region between Karaikal in the south and 'Swatch of No-ground' in the north have been taken up for studies on different aspects viz.,

- (i) Grain size distribution,
- (ii) Calcium Carbonate content,
- (iii) Coarse fraction constituents and
- (iv) Organic matter content.

While the analysis of the sediments between Madras and 'Swatch of No-ground' is still in progress, the study of the sediments off the Madras coast (between Madras and Karaikal) has been completed and the results obtained are briefly given below :

Grain size : In general, the sediments in the shelf region have their phi-median in the sand range. Off Madras, the sediments in the nearshore and outer shelf regions consist of fine to very fine sands while the sediments in the region in between are mostly medium sands. Off Karaikal, the sediments in the shelf and slope regions have their phi-medians in the range of medium to fine sands. A consideration of the sand-silt-clay variations in a cross section across the shelf shows that the silty clay percentage is considerable only in the nearshore and in the outer shelf region off Madras and in the slope region off Karaikal.

Calcium carbonate : The calcium carbonate content increases with depth along both the Madras and Karaikal sections. While the sediments in the inner shelf are characterised by a very low carbonate content, the middle and outer shelf are characterised by a relatively higher percentage of carbonate. The fine grain sediments in the regions of canyons are found to have a low carbonate content.

Coarse fraction studies : Coarse fraction constituents under study are categorised into lights (Quartz and Felspar), opaques, aggregates, oolites, foraminifera and shells including shell fragments. Terrigenous minerals (lights and opaques) mostly of quartz and felspar and a few grains of magnetite, sillimanite, zircon and other heavy minerals occur in the coarse fractions in abundance at depths less than 50 fathoms. Glauconite forms an important constituent among the opaques especially in the outer shelf sediments. The aggregates are composed of Quartz particles, small oolites, shells and shell fragments and they are found at depths of 30 to 50 fathoms. The oolitic grains constitute more

than 50% in the mid-shelf region. In the outer shelf region, while the general abundance of oolites decreases, they are found to be concentrated in the finer fractions.

Shells of gastropods and their fragments constitute the bulk of the skeletal material in any sample. The coarser material of the sediment samples at depths greater than 50 fathoms is composed mainly of shells and their fragments, tests of foraminifera, overwhelming the shells in the outer shelf region. Among the foraminifera identified, the important ones are Globigerina, Rotalia, Amphistigina, Elphidium, Quinquiloculina, etc. Rotalia, Amphistigina, Elphidium and Quinquiloculina have their maximum abundance in the mid shelf regions associated with oolites.

The conclusion that has been drawn from these studies is that the sediments beyond the 30 fathom depth might have been laid down when the sea level was relatively lower than the present day level and was not covered by the present day deposition of terrigenous sediments. It is also possible to conclude from these studies that the late Pleistocene lowered sea level affected the entire east coast of India.

C. Coastal and nearshore oceanographic studies

The observational programme fixed at the eight stations in the Cochin-Alleppey areas was continued during this year also. A total of 183 beach profiles were measured for all the eight stations. Vertical space sections and time sections were prepared and the rate and nature of changes taking place at every point of the beach studied. Volume changes were computed to assess the extent of sand involved in the changes taking place.

A programme for the study of coastal currents using T.S.K. self-recording current meters, floats and jelly bottles was started in August 1966. Observations are being made every month off Saudi and Ochanthuruth situated on either side of the Cochin Harbour approach channel. Current measurements are also being made near the piers at Trivandrum, Alleppey and Calicut.

Some of the results of the investigations undertaken on the coastal and nearshore oceanography are summarised below :

Investigations on the beach erosion of Kerala indicate that apart from the usual physical factors, like waves, tides, wind and the beach material, the part played by the backwaters in preventing the rivers and streams from nourishing the beaches walls and groynes have also to be considered in explaining the erosion and sedimentation along the coast.

Studies on the beach profile changes in time and space at points having different environments on the Kerala coast reveal that there are short term and seasonal changes as well as sudden changes. But in general the beaches do not appear to undergo much annual change except on the neighbourhood of artificial structures. The investigations also show that entirely different types of changes could occur within short distances along the coast.

Investigations on the seasonal changes in the characteristics of the beach material at Ochanthuruth (3 miles north of Cochin) and Narakkal (8 miles north of Cochin) show that at Narakkal (where the observation point is in the seawall and groyne zone) the beach is composed of fine sand and does not show any marked variation with seasons, while at Ochanthuruth where the point is in a free zone, the back shore is composed of medium sand during the monsoon period and fine sand during rest of the year.

Wave refraction studies for the coast of Kerala near Thottapally show that the coast is likely to be affected adversely by waves of higher periods approaching the coast. These studies show that for the waves coming from 200° and 220° , the long shore drift is towards the north and for the directions 280° , 300° and 320° , the drift is towards the south. For the directions 240° and 260° the direction of the drift varies with the orientation of the coast.

The coast of Kerala is occasionally subjected to severe storms which cause erosion at some places and sedimentation at others. The storm of December 1965 in the Arabian Sea was a severe one that caused considerable damage to the Kerala coast. While severe erosion occurred at several places, an extensive mud flat was formed slightly north of Cochin during this period. Through a detailed study of the significant heights and periods of the waves generated by the storms approaching the different parts of the coast line and taking into consideration the refraction suffered by the waves, it was possible to explain the processes of erosion along the Kerala coast and the formation of mud flat north of Cochin.

A comparison of the physical and chemical characteristics of the mud deposit off the Vypeen beach after the storm of December 1965 with those of off-shore samples indicates several similarities in their characteristics but some differences in phosphate-phosphorus, iron and strontium contents. These differences may be ascribed to the differences in the environment at the original site of deposition. It could be inferred from these studies that these muds originated very near the shore and are perhaps composed of dredged material.

D. Bathymetry and submarine canyons

Analysis of the data based on the bathymetric surveys conducted during the 26th cruise of INS *Kistna* reveals the existence of three sets of distinctly different canyons cutting across the shelf and slope regions near Cuddalore and Pondicherry. Starting from the southern-most canyon, these are named Cuddalore Canyon, Pondicherry (Puducherry) Canyon and Palar Canyon. The heads of these canyons are located around 20 to 30 fathoms. An examination of the longitudinal profiles for these canyons show that the Palar canyon has the steepest profile (average slope angle $6^{\circ}07'$) while the Cuddalore canyon has a more flat profile (average slope angle $4^{\circ}17'$) with the slope of the Pondicherry Canyon coming in between (average slope angle $4^{\circ}40'$). None of these canyons seem to lead into the present-day river channels.

E. Estuarine studies

Daily observations of air temperature and humidity, water temperature and salinity at different depths, transparency of the waters, tide level and speed of the currents at the surface, at boat-pen in the Ernakulam channel and weekly observations at M.E.S. Jetty and Cochin Port were continued. The data collected over a number of years at these places were analysed and the mean values of water temperature and salinity at different depths, turbidity of the waters, air temperature, etc. were calculated. Some preliminary studies on the variation of currents with depth were also carried out with the help of current meters.

2.4 BIOLOGICAL OCEANOGRAPHY DIVISION, ERNAKULAM

The work on hydrography and primary productivity of Cochin backwater which began in April 1965 is nearing completion. Nearly 18 months' data on various aspects have been collected. The investigations carried out during the year are:

I Physical factors

- (a) The relation between electrical conductance and chlorinity of Cochin backwater.
- (b) Solar radiation and its penetration in Cochin backwater.
- (c) The influence of tide on the hydrographical features of Cochin backwater.

II Chemical factors

- (a) The influence of environmental factors on the organic production of Cochin backwater.
- (b) The plant pigments of Cochin backwater.

III Biological factors

- (a) The organic production of Cochin backwater.
- (b) The phyto—and zooplankton crops of Cochin backwater.
- (c) Studies on the benthic fauna of Cochin backwater.

VI Microbiological factors

- (a) Some bacterial characteristics of Cochin backwater.
- (b) Studies on the bacterial population of Cochin backwater.

(I) Hydrography of inshore waters

With the co-operation of the Government of India Offshore Fishing Station and the Craft and Gear Wing of the Central Institute of Fisheries Technology, it has been possible to get shipboard facilities for field work. The work on hydrography of inshore

waters began in October 1966. Data on various aspects are being collected from one station, 20 miles away.

(2) Hydrography of offshore waters

The work on hydrography of offshore waters began in February 1967. Monthly cruises of 3 days duration are being undertaken by the offshore fishing vessels and 4 stations are being worked out. Analysis of samples is in progress.

(3) Fish and Fisheries

(a) Theoretical yield studies

As reported earlier, it is possible to make fairly accurate estimates of growth and mortality rates of the large scaled tongue sole, *Cynoglossus macrolepidotus*. Using this information, the reaction of the population to various mortality rates and ages of exploitation were worked out by applying Jone's version of Beverton and Holt model. This study has shown that the population of this fish is at present underfished and the yield could be considerably increased by increasing the fishing intensity. However, for maximising the yield the age of exploitation has also to be considered because for a given fishing mortality there is particular age of exploitation that will give the maximum yield.

(b) Studies on population models

In dynamical yield studies, the most widely used model is that of Beverton and Holt. However, the application of this model has certain limitations and therefore, the possibilities of modifying this model to make it more flexible for the estimation of yield of tropical fish populations have been examined. A modified method of approximate integration has been developed which seems to satisfy the basic requirements and gives an accurate estimate of yield.

(c) Trophic spectrum

To understand the utilisation of food organisms at different levels of the environment, the gut contents of trawl caught fishes were examined. In all, 35 different species were studied. The plankton component was dominant in 4 species, while neritic component was dominant in 6 species and the benthic component in 12 species. The rest had either no food or contained unrecognisable items.

(4) Benthos

A comparison of the benthic fauna of the nearshore region with that of the backwater indicates that while in the backwater the changes in salinity and nature of substrate are important in governing the distribution of the bottom fauna, in the sea since salinity conditions are more stable, nature of substrata seems to be a primary factor controlling their abundance.

(5) Hydrography of rivers

To get a fuller knowledge of the estuarine environment (backwater) which receives considerable amount of fresh water from the two main rivers, namely the Periyar and the Pampa, investigations were started on the hydrography of the two rivers. Regular monthly collections of plankton and water samples were made and investigations on nutrients, organic matter and plankton have revealed interesting results. The rivers seem to be characterised by a greater organic matter than the backwater. The silicate and nitrate contents of the rivers are also high while the phosphorus content is poor.

(6) Beach studies

Productivity studies are also being carried out on some selected sandy beaches of Kerala. Sand samples collected from (a) backwater beach (2) Cochin beach and (3) Thottapally beach are being analysed for organic matter and chlorophyll. The interstitial fauna of the Cochin beach is being studied qualitatively and quantitatively in detail.

(7) Physiology studies

During the year the following problems were investigated by a Research Fellow of the National Institute of Sciences :

- (a) The normal blood sugar level of the crab, *Scylla serrata*
- (b) The effect of eye-stalk ablation on the blood sugar level.
- (c) The effect of injection of eye-stalk extract on the blood sugar level of eye-stalk-less crabs.
- (d) The effect of insulin on normal and eye-stalk-less crabs.
- (e) The changes in the blood sugar and blood calcium during the premoult and reproduction phases of the crab.

2.5 BOMBAY UNIT OF THE NATIONAL INSTITUTE OF OCEANOGRAPHY, BOMBAY-I

Analysis of the plankton and sediments collected during the Cruise 1 on board INS DARSHAK in the Gulf of Cambay, April 8—23, 1966, was continued. The Chaetognaths in the plankton samples were sorted and identified. Chemical analysis of sediment samples was carried out for elements such as Manganese, Cobalt, Copper and Zinc.

Studies in the Gulfs of Cambay and Kutch were continued by organizing two more cruises in February/March 1967.

Salinity values both in the Gulf of Kutch and Gulf of Cambay have shown some remarkable variations during the 3 cruises and it is proposed to carry out more intensive studies before any explanation is offered.

Studies on the Foraminifera of the sediments have been started and more than 50 species have been identified.

Report on INS DARSHAK Cruise 2—Gulf of Kutch

SCHEDULE

Cruise period

January 27th to 1st February 1967.

Itinerary

January 27th Depart Bombay
January 27th | Occupy stations in the
to 1st February | Kutch area.
February 4th Leave Kandla
February 4th Arrive Bombay

PERSONNEL

Dr. T.S. Satyanarayana Rao, Scientist, NIO, Bombay
(Leader)

Dr. N.K. Srivastava, Pool Officer, NIO, New Delhi.

Shri K. Kameswara Rao, Jr. Sci. Asstt. NIO, Bombay.

Object. The Cruise was undertaken to study the hydrobiological conditions and the sediments in the Gulf of Kutch. During the cruise, 12 stations were occupied for collection of plankton, water sample & sediment cores. A gravity corer which was fabricated at the workshop of the Tata Institute of Fundamental Research, Bombay under the guidance of Dr. Robert L. Fisher of the Scripps Institution of Oceanography was used. The corer operated very well and the largest core obtained measured 5ft.

Weather & Currents. The weather was fine with occasional gusts of cold winds. The tidal currents were not strong. The days were bright with practically no clouds.

Salinity & Temperature. Salinity values are highly variable.

Salinity minimum	14.33‰
Salinity maximum	35.44‰
Temperature minimum	18.62°C
Temperature maximum	25.29°C

Plankton. All the samples were rich in copepods and chaetognaths. These groups are being sorted and analysed.

Sediments. Cores obtained by the Gravity Corer are being processed for their geochemistry and foraminifera.

Cruise Report—INS DARSHAK Cruise 3—Gulf of Cambay

SCHEDULE

Cruise period

March 14-19, 1967.

Itinerary

March 14 Depart Bombay
March 16-19 Occupy stations in the Gulf of
Cambay.
March 20 Return to Bombay.

OCEANOGRAPHIC LOG SHEET

Bombay to Gulf of Kutch

27th January to 1st February, 1967

Stn. No	Date & time	Latitude (North)	Longitude (East)	Depth of Water	Wind Direction	Wind Force (in knots)	Pressure (Mbs)	Air temp. dry°C	Air temp. wet°C	Cloud amount (in Octants of the Globe)	Direction of Sea	Ht of Sea	Direction of swell	Ht of swell	Visibility	Salinity *	T C
January																	
20	1505 27th	18°54'N	72°21.5'E	28 fms	NNW	15 knots	1013.0	23.0	21.1	2/8	NW	3 ft.	—	—	Good	21.37	25.29
21	1805 27th	19°7'N	72°2'E	35 fms	NNW	10 knots	1013.0	22.2	20.6	1/8	NW	2 ft.	NW	5 ft.	Good	28.13	24.71
22	0200 28th	19°47.5'N	71°09'E	35 fms	NNW	15 knots	1012.5	23.3	20.8	2/8	NW	3 ft.	NW	5 ft.	Good	11.94	23.89
23	0805 28th	20°16.7'N	70°34.5'E	42 fms	NNW	15 knots	1014.5	21.7	18.3	—	NNW	3 ft.	NW	4 ft.	Good	35.08	23.89
24	2200 28th	21°43.6'N	69°14.6'E	20 fms	NNW	20 knots	1015.5	21.7	21.4	—	NNW	3 ft.	NW	3 ft.	Good	21.46	24.71
25	0610 29th	22°31'N	68°30'E	14½ fms	N	25 knots	1016.0	20.0	16.4	—	NNE	3 ft.	N	4 ft.	Good	35.44	21.95
26	1425-1440 29th	23°18'N	68°16'E	7½ fms	NW	10 knots	1017.0	22.2	17.2	—	NNW	2 ft.	NW	2 ft.	Good	14.33	21.10
27	1445-1500 31st	23°22'N	68°18'E	6 fms	NW	10 knots	1016.00	21.4	18.6	—	NW	3 ft.	NW	3 ft.	Good	25.07	21.95
28	2345-2400 31st	23°08'N	68°23'E	8½ fms	NW	5 knots	1015.0	22.8	20.8	—	NW	1 ft.	N	1 ft.	Good	21.46	20.00
29	February 0230 1st	22°59'N	68°44.2'E	7 fms	NW	5 knots	1015.0	20.0	16.9	—	NW	½ ft.	—	—	Good	26.15	19.85
30	1000-1025 1st	22°47'N	69°21'E	10.5 mtr.	NW	—	—	20.0	18.9	—	—	10½ ft.	—	—	Good	24.92	19.45

Stn. 31 off Mandvi; exact position was not noted.

*Salinity values doubtful

PERSONNEL

Dr. T.S. Satyanarayana Rao, Scientist, NIO, (Leader)
Dr. N.K. Srivastava, Pool Officer, NIO, New Delhi.
Shri K. Kameswara Rao, Jr. Sci. Asstt. NIO, Bombay.

Object of the cruise. The object of the cruise was to continue studies of the Gulf of Cambay which were initiated in April 1966.

Weather currents. During the Cruise there was clear weather. The tidal currents were strong.

Salinity and temperature. This time of the year the salinity readings showed higher values than those of the last year.

Salinity Values	1967	1966
Minimum	34.54°/°°	24.87°/°°
Maximum	35.48°/°°	28.35°/°°

Temperature values

Minimum	24.72 °C	25.20 °C
Maximum	25.85 °C	28.61 °C

Sediments and mudbanks. The bottom is mainly sandy and at stations 32,33, 34,36 & 37; no core or snapper samples could be obtained. Towards the mouth of the Gulf, clay fraction increases in the bottom muds. The 'mud banks' were again noticed in large numbers floating up and down with the tidal currents.

Plankton. Samples collected inside Gulf were poor in numbers of plankton organisms when compared to those collected nearer the mouth of the Gulf. At station No. 32 a large number of fish larvae were found.

Cruise : 3

OCEANOGRAPHIC LOG SHEET

Bombay to Gulf of Cambay

14th March to 19th March, 1967

Station Nos.	Date	Time	Latitude N	Longitude E	Depth Metres	Current	Air temp. °C		Wind speed	Cloud amount	Visibility miles	Salinity	Temper- ature °C
							Dry	Wet					
32	16-3-67	1540	21°20'.0	72°18'.9	21.95	—	26.7	24.4	—	—	—	34.81	25.82
33	17-3-67	0935	21°24'.0	72°21'.0	25.00	SW	25.6	23.6	10-15 knots	bc7/8	8	34.67	24.70
34	17-3-67	1135	21°30'.0	72°23'.0	24.00	SW	24.7	22.8	10-15 knots	bc7/8	8	34.54	25.30
35	17-3-67	1335	21°33'.0	72°24'.6	32.00	SW	25.8	23.1	10 knots	7/8	8	34.58	24.70
36	18-3-67	1130	21°09'.0	72°07'.5	21.95	S	25.3	22.2	10-15 knots	3/8	8	34.72	25.00
37	18-3-67	1530	21°12'.5	72°14'.5	25.60	N	26.4	23.9	10-15 knots	1/8	8	34.81	25.29
38	19-3-67	1115	20°37'.7	71°41'.4	18.00	S	26.9	22.8	7-8 knots	0/8	10	34.99	25.75
39	19-3-67	1630	19°54'.5	71°58'.2	32.00	Slack water	26.7	22.8	8-9 knots		10	35.48	25.86

3. ADMINSTRATIVE SET-UP

3.1 Executive Council

- | | | |
|----|--|----------|
| 1. | Dr. D.N. Wadia,
National Professor and Geological
Adviser to the Government of India,
Department of Atomic Energy,
South Block, <i>New Delhi</i> . | Chairman |
| 2. | Dr. D.V. Bal,
Member, Commission for
Scientific & Technical Terminology
UGC Buildings,
Bahadurshah Zafar Marg,
<i>New Delhi</i> . | Member |
| 3. | Dr. S.K. Bhattacharya,
Chief Hydraulic Engineer,
Calcutta Port Commissioners,
<i>Calcutta</i> . | Member |
| 4. | Dr. A.K. Ganguly,
Head, Health Physics Division,
Bhabha Atomic Research Centre,
Trombay, <i>Bombay</i> . | Member |
| 5. | Shri C.V. Gole,
Director,
Central Water & Power Research Station,
Khadakwasla, P.O., <i>Poona</i> . | Member |
| 6. | Dr. Hari Narain,
Director,
National Geophysical Research Institute,
<i>Hyderabad</i> . | Member |
| 7. | Capt. D.C. Kapoor, I.N.,
Chief Hydrographer to the Govt. of India,
Naval Hydrographic Office,
<i>Dehradun</i> . | Member |
| 8. | Dr. C.V. Kulkarni,
Director of Fisheries,
Government of Maharashtra,
<i>Bombay</i> . | Member |

- | | | |
|-----|--|--------|
| 9. | Prof. D. Lal,
Tata Institute of Fundamental Research,
Colaba,
<i>Bombay.</i> | Member |
| 10. | Shri R. Madhavan Nair,
Cochin Company Private Ltd.,
XXIII/1366, M.G. Road,
Post Box No. 12,
<i>Ernakulam.</i> | Member |
| 11. | Prof. P.R. Pisharoty,
Physical Research Laboratory,
Navarangpura,
<i>Ahmedabad.</i> | Member |
| 12. | Shri S.K. Ranganathan,
Director of Scientific Research (Navy),
Naval Headquarters,
<i>New Delhi.</i> | Member |
| 13. | Capt. N.S. Tyabji, I.N. (Retd.)
Assistant General Manager,
Gujarat Refineries,
Gujarat Refineries, P.O.
Baroda District, <i>Gujarat.</i> | Member |
| 14. | The Financial Adviser to CSIR | Member |
| 15. | The Director-General
Scientific & Industrial Research
Rafi Marg, <i>New Delhi.</i> | Member |
| 16. | Director
National Institute of Oceanography,
<i>New Delhi.</i> | Member |

3.2 SUB-COMMITTEES OF THE EXECUTIVE COUNCIL

1. SCIENTIFIC SUB-COMMITTEES

1. Physical & Chemical

1. Dr. M.S. Krishnan
2. Dr. P.R. Pisharoty
3. Shri C.V. Gole

4. Shri S.K. Ranganathan
5. Dr. A.N. Bose
6. Prof. D. Lal
7. Dr. C. B. Murty
8. Dr. R. Viswanathan
9. Director, NIO

Convener

II Biological

1. Dr. D.V. Bal
2. Shri R. Madhavan Nair
3. Dr. R. Raghu Prasad
4. Dr. B.S. Bhimachar
5. Prof. P.N. Ganapati
6. Dr. B. Patel
7. Director, NIO

Convener

III Geological

1. Dr. D.N. Wadia
2. Dr. Hari Narain
3. Director-General, Geological Survey of India.
4. Director, NIO

Convener

VI Building & Finance Sub-Committee

1. Dr. D.N. Wadia
2. Capt. N.S. Tyabji
3. Secretary, CSIR
4. FA to CSIR
5. Chief Engineer, PWD, Goa Admn.
6. Development Commissioner, Goa Admn.
7. Director, NIO

Convener

V Staff Sub-Committee

1. Dr. C.V. Kulkarni
2. Shri R. Madhavan Nair
3. Dr. A.N. Bose
4. Director, NIO

Convener

The Executive Council also decided that the concerned Heads of divisions in the Institute will also be ex-officio Members of the Scientific Sub-Committees.

3.3 BUDGET

The budget figures for the institute for the year 1966-67 are as follows :

	<i>Sanctioned</i> (Rs. in lakhs)	<i>Actual</i> (Rs. in lakhs)
1. Recurring	7.256	7.279
2. Capital	0.900	0.901
	8.156	8.180

3.4 SCIENTIFIC & TECHNICAL STAFF

1. Headquarters and Planning & Data Division

DIRECTOR

Dr. N.K. Panikkar

Scientist-in-charge
(Planning & Data Division)
Shri R. Jayaraman

Scientist
Dr. S.N. Dwivedi

Pool Officers
Dr. P.V. Dehadrai
Dr. N.K. Srivastava

Senior Technical Assistants
Shri R.M.S. Bhargava
Shri U.K. Gopalan

Junior Scientific Assistant
Shri R.M. Kidwai

Senior Research Fellow
Shri L.V. Gangadhara Rao

3.4. 2. Indian Ocean Biological Centre, Ernakulam

Chief Scientist-in-charge

Dr. R. Raghu Prasad (Part-time)

Scientist-in-charge
Shri M. Krishna Menon

Scientists
Shri L.R. Kasturirangan
Dr. R.V. Unnithan

Senior Scientific Assistants
Shri P. Gopala Menon
Shri M. Sakthivel
Shri K.J. Peter

Junior Scientific Assistants
Shri P.N. Aravindakshan
Shri Jacob George
Shri George Peter
Shri V.T. Paulinose
Smt. Vijayalakshmi R. Nair
Shri T. Balachandran
Shri K. Gopalakrishnan
Smt. Lalithambika Devi

3.4. 3 Physical Oceanography Division, Ernakulam

Scientist-in-charge

Dr. V.V.R. Varadachari

Scientist

Shri V.S. Rama Raju

Senior Scientific Assistant

Shri C. Satyanarayana Murty

Junior Scientific Assistants

Shri P.K. Das

Shri V. Hariharan

Shri P. Udaya Varma Thirupad

Senior Research Fellows

Shri P.S.N. Murty

Shri R.R. Nair

Shri Ch. Madhusudana Rao

3.4. 4 Biological Oceanography Division, Ernakulam

Scientist-in-charge

Dr. S.Z. Qasim

Scientists

Dr. M. Krishnan Kutty

Shri C.V. Gangadhara Reddy

Pool Officer

Dr. B.N. Desai

Senior Scientific Assistants

Shri S. Rajan

Shri B.M. Panikkar

Shri P.M.A. Bhattathiri

Junior Scientific Assistants

Shri S. A.H. Abidi

Smt. N. Santhakumari

Senior Research Fellows

Shri V.N. Sankaranarayanan

Shri P. Sivadas

Shri V.P. Devasy

3.4. 5 Bombay Office of NIO

Scientist

Dr. T.S. Satyanarayana Rao

Junior Scientific Assistant

Shri K. Kameswara Rao

4. LIBRARY

The Library facilities are available at all the Divisions and Units of the Institute. There is a common Library for all the divisions at Ernakulam with a full time Librarian. The total number of books in the stock of the Institute is 2,045 out of which 855 are in Delhi and rest in Ernakulam.

The library receives and issues books and periodicals on inter-library loan basis with the libraries of various institutions in the country.

5. AWARDS, HONOURS & MEMBERSHIP OF VARIOUS COMMITTEES

Dr. R. Raghu Prasad, Chief Scientist-in-Charge, Indian Ocean Biological Centre, Ernakulam attended the Second International Oceanographic Congress held in Moscow from 30th May to 9th June, 1966. Dr. Prasad was one of the invited speakers and he read a paper on "Recent advances in the study of Production in the Indian Ocean" in the session "Indian Ocean and the Antarctic".

Dr. V.V.R. Varadachari, Scientist, was nominated by the Geophysical Research Board of CSIR as a member of the Working Group for Continental Margins and Island Areas of the Indian Ocean Programme for the Upper Mantle Project.

Sarvashri P. Gopal Menon & M. Sakthivel, Senior Scientific Assistants, were awarded UNESCO Fellowships to attend the Advanced Course in Marine Biology held in Copenhagen, Denmark in April-May 1966. On completion of the training they visited Oceanographic Laboratory, Edinburgh, Marine Biological Laboratory, Plymouth and British Museum, London to acquaint themselves with the planktonic studies carried out in these institutions with particular reference to the groups Chaetognatha, Pteropoda etc.

6. DEPUTATIONS

6.1 Dr. N.K. Panikkar, Director

U.S.S.R.

To attend the Second International Oceanographic Congress in Moscow. He presided over the Session 'Indian Ocean and Antarctic' and gave a lecture on 'Fishery Resources of the Indian Ocean'. (Invitation from the Congress & FAO)

FRANCE

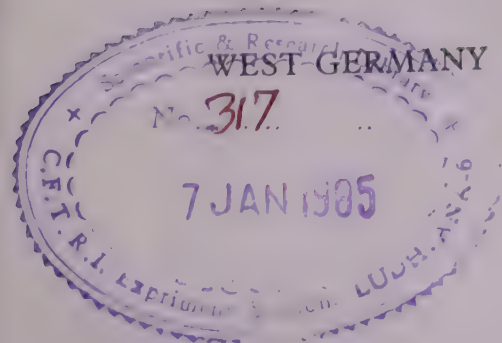
To attend the meeting of the Working Groups of the Intergovernmental Oceanographic Commission in Paris and for discussions with the French Institute of Petroleum on recent geophysical methods for ocean research. (On invitation from French Institute of Petroleum).

U.A.R.

To visit the Oceanographic and Marine Fisheries Institutions under Scientists' Exchange Programme. (Invitation from U.A.R.)

WEST-GERMANY

To participate in the VII International Congress on Nutrition in Hamburg (Invitation for Congress authorities in West Germany).



ITALY

To participate in the meeting of the Working Party of the Advisory Committee on Marine Resources Research of F.A.O. in Rome (Invitation from FAO).

7. DISTINGUISHED VISITORS

1. Dr. A.D. McIntyre, Marine Laboratory, Aberdeen, Scotland.
2. Mr. A.S. Gladhikh, Institute of Medicinal Plants, Moscow.
3. Mr. I.M. Rabinovich, Institute of Medicinal Plants, Moscow.
4. Mr. I.A. Gubanov, Institute of Medicinal Plants, Moscow.
5. Prof. R.V. Seshaiya, Director, Marine Biological Station, Annamalai University, Porto Novo.
6. Mr. Philip R. Nelson, Chief of the Branch of Inland Fisheries in the Bureau of Commerical Fisheries, Washington, D.C., U.S.A.
7. Dr. Jean Bouillon, Professor, University of Brussels, Belgium.
8. Mr. B.F. Dada, M.A.N.R. Fisheries Division, Ibadan, Nigeria.
9. Dr. J. Steele, Marine Laboratory, Aberdeen, Scotland.
10. Rear Admiral S.N. Kohli, Deputy Chief of Naval Staff, New Delhi.
11. Commodore J.D. Mody, Commodore-in-charge, Naval Base, Cochin-4.
12. Dr. J.P. Harding, British Museum (Natural History), London.
13. Mr. W. Lise, University of Hamburg, West Germany.
14. Mr. Zafar Futehally, Bombay Natural History Society, Bombay.
15. Prof. Michitaka Uda, Tokyo University of Fisheries, Japan.
16. Mr. Robert H.G. Clark, Y.M.C.A. Martandam.
17. Dr. Fred H. Berry, U.S. Bureau of Commercial Fisheries, Florida.
18. Dr. H. Grane Miller, Smithsonian Institution, Washington, D.C., U.S.A.
19. Dr. Kenneth G. McKenzie, Monash University, Clayton, Victoria, Australia.
20. Dr. E.C. LaFond, U.S. Navy Electronics Laboratory, Sandiego, California, U.S.A.
21. Dr. J.E.G. Rayment, Department of Oceanography, University of Southampton, U.K.
22. Dr. D.T. Gauld, Department of Natural History, University of Aberdeen, Scotland.
23. Dr. A.H. Ahlstrom, U.S. Bureau of Commercial Fisheries, La Jolla, California, U.S.A.
24. Dr. Walter Fischer, Estacion de Biologia Marina, Chile.
25. Dr. R. Serene, c/o National Museum, Singapore.
26. Prof. S. Krishnaswamy, Madurai University, Madurai.
27. Dr. A. Fleminger, Scripps Institution of Oceanography, La Jolla, California, U.S.A.
28. Dr. M. Anraku, Seikai Regional Fisheries Research Laboratory, Japan.
29. Dr. Vladimir N. Greze, Institute of Biology of South Seas, Sevastopol, USSR.

30. Prof. J. Krey, Institute fur Meereskunde, Universitat, Kiel, West Germany.
31. Mr. Davind J. Tranter, C.S.I.R.O., Cronulla, Sydney, Australia.
32. Dr. A.G. Evstafiev, Director, Unesco Regional Office, New Delhi.
33. Mr. K.R. Dyer, Department of Oceanography, Southampton University, England.
34. Dr. Y. Nayudamma, Director, Central Leather Research Institute, Adyar, Madras-20.
35. Dr. D.V. Bal, Member, Scientific & Technical Terminology Commission, Ministry of Education, New Delhi.
36. Dr. Nina N. Gorbunova, Institute of Oceanology, Moscow, USSR.

8. EXHIBITION, SEMINARS, SYMPOSIA ETC.

8.1 Seminars (Held at the Indian Ocean Biological Centre, Ernakulam)

<i>S.N.</i>	<i>Name of the speaker</i>	<i>Institution</i>	<i>Subject</i>
1.	Dr. N.K. Panikkar	Director, N.I.O. (India)	Anthozoan Larvae
2.	Dr. Kenneth A. McKenzie	Monash University (Australia)	Ostracods
3.	Dr. N.N. Gorbunova	Institute of Oceanology, Moscow (USSR)	Fish eggs and larvae
4.	Dr. Fred H. Berry	Bureau of Commercial Fisheries, Florida (USA)	Fish Taxonomy
5.	Dr. E.H. Ahlstrom	U.S. Bureau of Commercial Fisheries, Sandiego (USA)	Fish eggs and larvae.
6.	Dr. A. Fleminger	Scripps Institution of Oceanography (USA)	Calanoid Copepods

8.2 Symposia

8.2.1 Symposium on "Coastal and Nearshore Oceanography"

A 3-day symposium on "COASTAL AND NEARSHORE OCEANOGRAPHY" was organized jointly by the Indian National Committee on Oceanic Research and the National Institute of Oceanography. It was inaugurated at Central Institute of Fisheries Operatives, Ernakulam on the morning of 4th November 1966 by Dr. K.L. Rao, Minister of State for Irrigation and Power, Government of India. Prof. M.S. Krishnan, former Director of the Geological Survey of India and the National Geophysical Research Institute delivered a lecture on "Evolution of the Coasts of India" at the inaugural session, and this was followed by scientific sessions. Scientists from various institutions in India and abroad participated and read a number of papers under the following five sections.

1. Waves, tides, currents, sea level variation and storm surges.
2. Hydrography of shallow waters and estuaries.
3. Shore processes, beach material and sediment transport.

4. Nearshore sediments, Geomorphology and Indian Coasts and Harbour problems.
5. Biological and other miscellaneous studies.

The abstracts of papers read in the symposium have been published in the "SYMPOSIUM NUMBER" of the Newsletter of the International Indian Ocean Expedition Vol. IV, No. 2, September, 1966.

8.2.2 Symposium on "INDIAN OCEAN"

A Symposium on "INDIAN OCEAN", organized by the Indian National Committee on Oceanic Research (CSIR) and the National Institute of Sciences of India from 2nd through 4th March, 1967 was held at the auditorium of NISI, Bahadurshah Zafar Marg, New Delhi-1. The objective of the symposium was to bring together the scientific workers in different disciplines of Oceanography from different institutions in India and also scientists from abroad who had actively participated in the International Indian Ocean Expedition, to a common forum to discuss the results obtained during the expedition and to develop new aspects of investigations in the Indian Ocean. Besides the data collected during the IIOE, the Symposium also discussed some of the earlier work carried out in the Indian Ocean with a view to providing newer interpretations to these earlier findings based on recent concepts and theories in Oceanography.

The Symposium was organized under the following sections :

1. Physical and Chemical Oceanography, including Geochemistry and Radiochemistry
2. Geology and Geophysics
3. Marine Biology including Productivity
4. Fisheries
5. Maritime Meteorology

The abstracts of the papers presented at the Symposium were published in a special number of the International Indian Ocean Expedition Newsletter Vol. IV, No. 4, March 1967. The full papers will be published in a special Symposium Number of the National Institute of Sciences of India.

9. COLLOQUIA AND SPECIAL LECTURES:

Lectures by visiting scientists at Ernakulam

<i>S.N.</i>	<i>Name of the lecturer</i>	<i>Department (country)</i>	<i>Subject of lecture</i>
1.	Prof. R.V. Seshaiya	Marine Biological Station, Porto Novo (Madras)	Recent advances in Marine biology.
2.	Dr. J.P. Harding	British Museum (Natural History) London, U.K.	British Museum (Natural History).

3.	Dr. W. Liese	University of Hamburg West Germany.	Wood Biology.
4.	Dr. Michitaka Uda	University of Fisheries, Tokyo Japan.	Exploratory Fishing.
5.	Mr. Fred H. Berry	Bureau of Commercial Fisheries, Miami, Florida (USA)	Identification Key for Clupeoid fishes of the World.
6.	Dr. E.C. LaFond	U.S. Navy Electronics Laboratory San Diego (USA)	Oceanographic Instrumentation.
7.	Dr. J.E.G. Raymont	University of Southampton (U.K)	Carbohydrates in Invertebrates.
8.	Dr. V.N. Greze	Institute of Biology of the South Seas, Sevastopol (USSR)	Biological Productivity.
9.	Dr. S. Krishnaswamy	Madurai University (INDIA)	Electron microscope studies on <i>Calanus finmarchicus</i> .
10.	Dr. John Krey	Kiel University (West Germany)	Distribution of Parti- culate matter in the Indian Ocean.
11.	Dr. M. Anraku	Seikai Regional Fisheries Research Laboratory (Japan)	Studies on the migra- tion of the pacific sardine.
12.	Dr. A. Fleminger	Scripps Institution of Oceanogra- phy (USA)	Distribution of Co- pepods in the Gulf of Mexico and ad- jacent areas.
13.	Mr. David J. Tranter	CSIRO, Sydney, Australia	Biology of Corals.

10. PUBLICATIONS

10.1 Publications of the Institution

1. International Indian Ocean Expedition-Newsletter, India
Vol. IV, No. 1 to 4, 1966-67.
2. Annual Report, NIO, 1965-66.

10.2 Papers and Abstracts published by the staff members

10.2.1. Papers.

27. Krishnan Kutty, M., 1967. Observations on the growth and mortality of the large-
scaled tongue sole, *Cynoglossus macrolepidotus* (Bleeker) *Proc. Nat. Inst. Sci.
India*, 33 B, 94-110.
28. Qasim, S.Z. and C.V.G. Reddy, 1967. The estimation of plant pigments of Co-
chin backwaters during the monsoon months. *Bull. Mar. Sci.* 17.

10.2.2. Abstracts

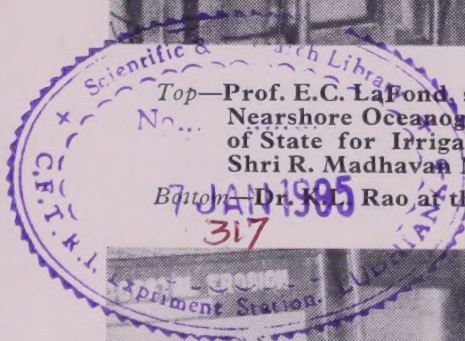
1. Anand, S.P., C.B. Murty, R. Jayaraman and B.M. Agarwal, 1967. Distribution of temperature and oxygen in the Arabian Sea and Bay of Bengal during the monsoon season. *I.I.O.E. Newsletter, India* IV (4): 2 (abstract).
2. Aravindakshan, P.N. 1967. A preliminary report on the geographical distribution of the species of Carinariidae and Pterotracheidae (Heteropoda, Mollusca) from the IIOE, *Ibid.* IV (4): 3 (abstract).
3. Desai, B.N. and M. Krishnan Kutty, 1967. A comparison of the marine and estuarine benthic fauna of the nearshore regions of the Arabian Sea. *Ibid.* IV (4): 11 (abstract).
4. Dwivedi, S.N. 1967. Identification of fish populations with particular reference to the pelagic fish stocks of the Indian Ocean region. *Ibid.* IV (4): 11 (abstract).
5. ———. Tuna resources of the Indian Ocean. *Ibid.* IV (4): 11 (abstract).
6. Garg, J.N., C.B. Murty and R. Jayaraman, 1967. Vertical distribution of the oxygen in the Bay of Bengal and Andaman Sea during February—March 1963. *Ibid.* IV (4): 12 (abstract).
7. Gopalakrishnan, K. and E. Brinton, 1967. Preliminary study of the distribution of Euphausiacea from IIOE. *Ibid.* IV (4): 12 (abstract).
8. Gopalan, U.K. 1967. Studies on the maturity and spawning of silver pomfret, *Pampus argenteus* (Euphr) in the Arabian Sea. *Ibid.* IV (4): 13 (abstract).
9. George, Jacob, 1967. A preliminary report on the distribution and abundance of planktonic Ostracods in the Indian Ocean. *Ibid.* IV (4): 14 (abstract).
10. Krishnan Kutty, M. and S.Z. Qasim, 1967. Theoretical yield studies on the large-scaled tongue sole, *Cynoglossus macrolepidotus* (Bleeker) from the Arabian Sea, *Ibid.* IV (4): 17 (abstract).
11. Madusudhana Rao Ch. and P.S.N. Murty, 1967. Studies on the shelf sediments off the Madras Coast. *Ibid.* IV (4): 20 (abstract).
12. Menon, Balachandra, T. and N.K. Panikkar, 1967. Preliminary studies of the distribution of planktonic Anthozoa (Coelenterata) in the Indian Ocean. *Ibid.* IV (4): 22 (abstract).
13. Murty, C.S. and V.V.R. Varadachari, 1967. Upwelling along the east coast of India. *Ibid.* IV (4): 22 (abstract).
14. Murty, P.S.N. and C.V.G. Reddy, 1967. Distribution of phosphorus in the marine sediments off the east coast of India. *Ibid.* IV (4): 22 (abstract).
15. Nair, K.V.K. and P.M.A. Bhattathiri, 1967. Current measurements at Angria Bank in the Arabian Sea. *Ibid.* IV (4): 23 (abstract).
16. Panikkar, N.K., 1967. Fisheries resources of the Indian Ocean. *Ibid.* IV (4): 24 (abstract).
17. Peter, George, 1967. A preliminary report on the general distribution and seasonal variation in abundance of pelagic polychaetes in the Indian Ocean. *Ibid.* IV (4): 25 (abstract).
18. Peter, K.J., 1967. Larvae of *Rastrelliger kanagurta* (Cuvier) from the Indian Ocean. *Ibid.* IV (4): 25 (abstract).
19. ———, 1967. Preliminary report on the density of fish eggs and larvae of the Indian Ocean. *Ibid.* IV (4): 26 (abstract).

20. Rama Raju, V.S., 1967. Observations on the scattering layers over the continental shelf off Konkan Coast (India) *Ibid.* IV (4): 32 (abstract).
21. Rao, Gangadhara L.V. and Jayaraman, R., 1967. Hydrographical features of the southern and central Bay of Bengal during the transition period between winter and summer. *Ibid.* IV (4): 32 (abstract).
22. _____, 1967. Vertical distribution of temperature, salinity and density in the upper 500 metres of the north equatorial Indian Ocean during the north-east monsoon period. *Ibid.* IV (4): 36 (abstract).
23. Rao, Chalapati V. and Rao Satyanarayana, T. S., 1967. Distribution of total phosphorus in the Bay of Bengal. *Ibid.* IV (4): 36 (abstract).
24. Reddy Gangadhara, C.V. and V.N. Sankaranarayanan, 1967. Distribution of phosphates and silicates in the central western north Indian Ocean in relation to some hydrographical factors. *Ibid.* IV (4) 38 (abstract).
25. _____, 1967. Distribution of nutrients in the shelf waters of the Arabian Sea along the west coast of India. *Ibid.* IV (4): 38 (abstract).
26. Sakthivel. M., 1967. Preliminary report on the distribution of Pteropoda (Thecosomata) from the International Indian Ocean Expedition. *Ibid.* IV (4): 39 (abstract).
27. Sankaranarayanan, V.N. and C.V. Gangadhara Reddy, 1967. The nutrients of the north-western Bay of Bengal. *Ibid.* IV (4): 39 (abstract).
28. Sen Gupta, R. and A. Plyee, 1967. Specific alkalinity in the northern Indian Ocean during the south-west monsoon. *Ibid.* IV (4): 45 (abstract).
29. Varadachari, V.V.R. and C.S. Murty, 1967. Some observations on internal waves in the Bay of Bengal. *Ibid.* IV (4): 45 (abstract).
30. Varadachari, V.V.R., C.S. Murty and P.K. Das, 1967. On the level of least motion and the circulation in the upper layers of the Bay of Bengal. *Ibid.* IV (4): 45 (abstract)
31. Varadachari, V.V.R., C.S. Murty and P. Udaya Varma Thirupad, 1967. Some features of the thermocline in the Bay of Bengal. *Ibid.* IV (4): 45 (abstract)
32. Varadachari, V.V.R., R.R. Nair and P.S.N. Murty, 1967. Submarine canyons off the Coromandal coast. *Ibid.* IV (4): 45 (abstract).
33. Vijayalakshmi R. Nair, 1967. A preliminary report on the biomass of Chaetognaths in the Indian Ocean comparing the south-west and north-east monsoon periods. *Ibid.* IV (4): (abstract).



Top—Prof. E.C. LaFond, speaking at the inauguration of the Symposium on “Coastal and Nearshore Oceanography”—sitting (from left to right) Dr. K.L. Rao, Union Minister of State for Irrigation and Power, Prof. M.S. Krishnan, Dr. N.K. Panikkar and Shri R. Madhavan Nair.

Bottom—Dr. K.L. Rao at the Oceanographic Exhibition organised during the Symposium.





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